

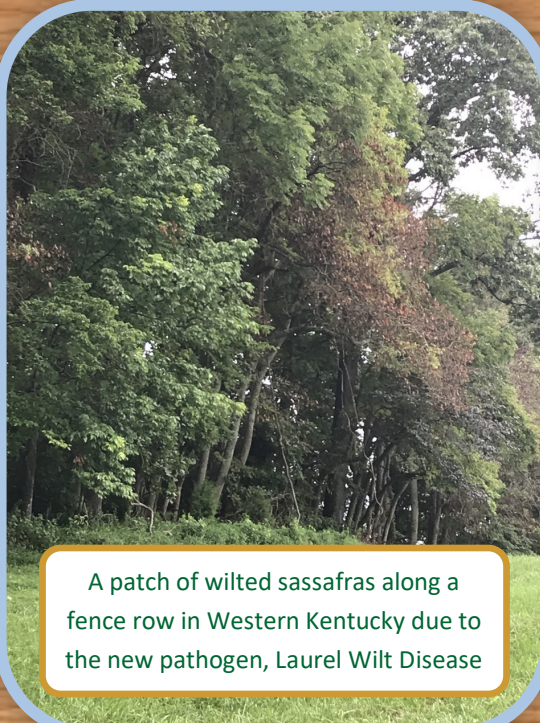
2020 Forest Health Highlights

from the Kentucky Division of Forestry

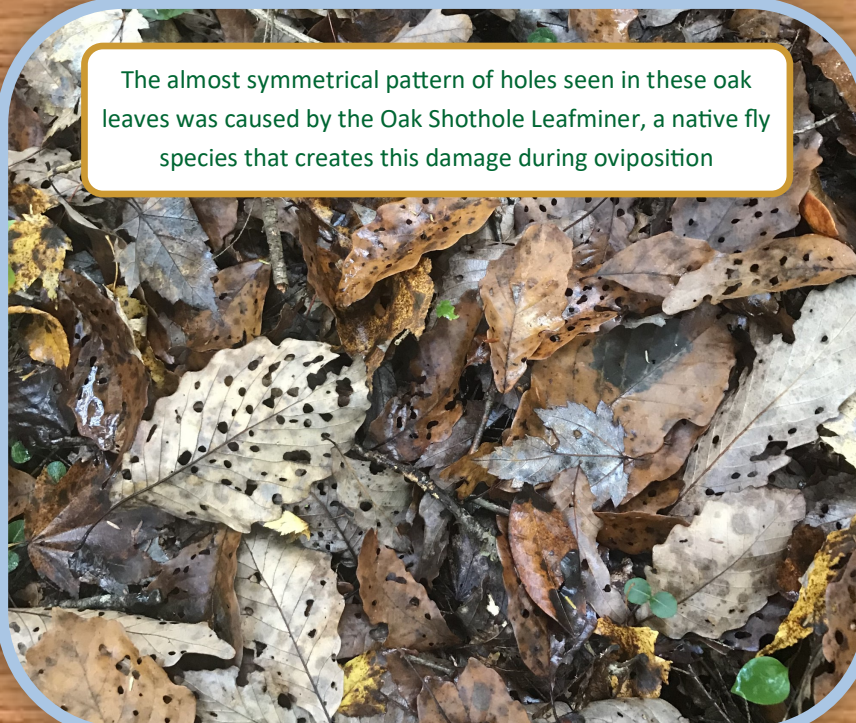


Drone image of frost injury to yellow poplar in Eastern Kentucky due to the record setting cold snaps in April and May

Kentucky is home to nearly 13 million acres of some of the nation's most diverse woodlands. Yet, this valuable resource is under attack. The most severe threats to our forests are insects, diseases, invasive plants, and occasional bouts of extreme weather. This document touches on the most influential of these disturbances and provides an up-to-date review of their impacts within the Commonwealth over the past year.



A patch of wilted sassafras along a fence row in Western Kentucky due to the new pathogen, Laurel Wilt Disease



The almost symmetrical pattern of holes seen in these oak leaves was caused by the Oak Shothole Leafminer, a native fly species that creates this damage during oviposition

EXOTIC INSECT PESTS

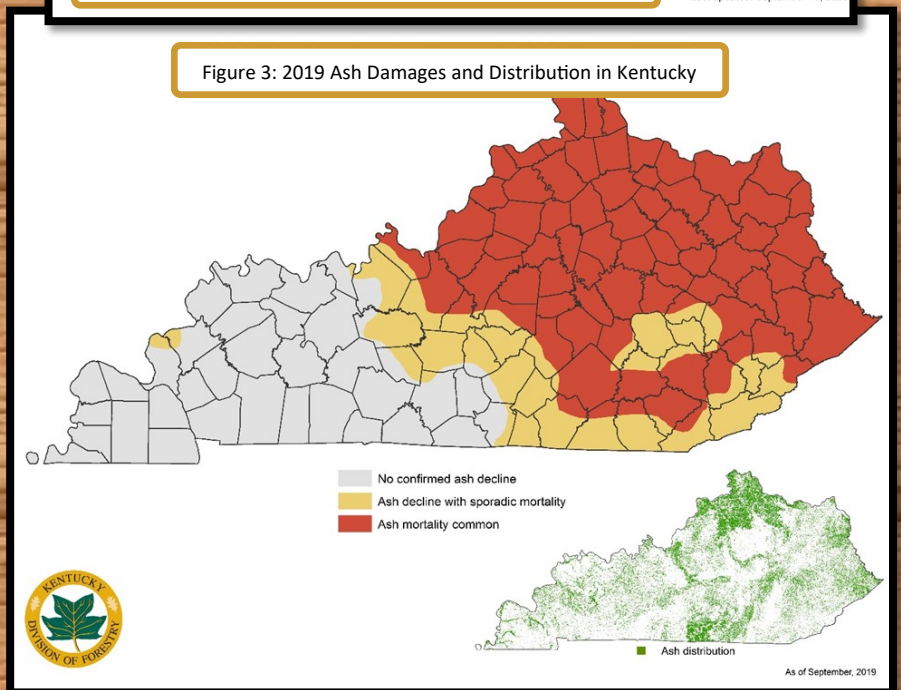
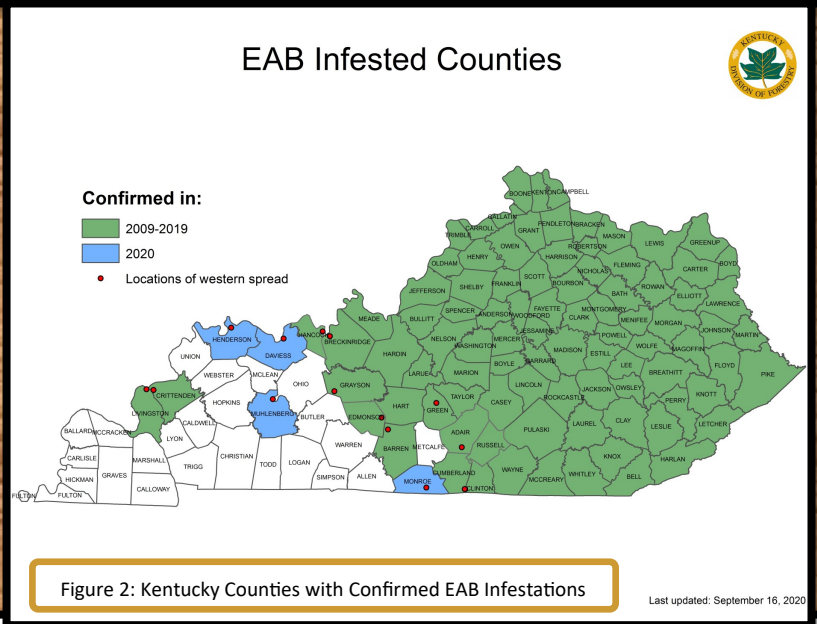
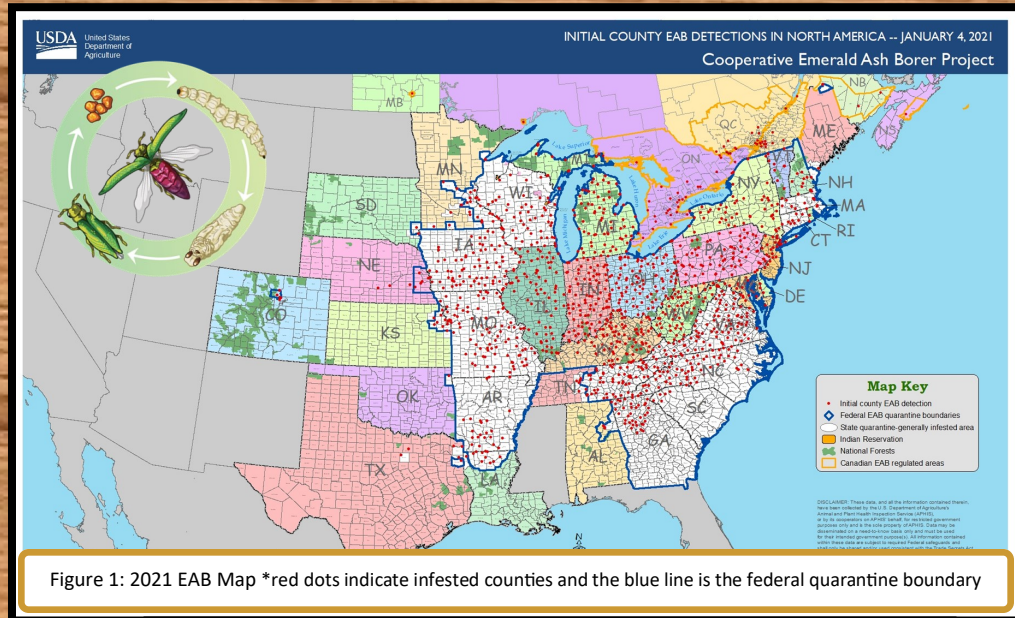
EMERALD ASH BORER

Since its initial discovery within US borders in 2002, this exotic pest has continued to cover new ground throughout the country and can now be detected in 35 states (Figure 1). Naturally this small beetle can only disperse a few miles per year on its own. Therefore, these expansions are often caused by human assists such as the movement of firewood or other infested material. This pattern is mirrored within the Commonwealth as this pest begins to pop up in western counties.

Infestations of the emerald ash borer (EAB) were first confirmed in Kentucky in 2009. A quarantine of 20 northern Kentucky counties, located in the region between Louisville and Lexington, was initially established. In the following years, additional EAB infestations were found in nearby counties and the state quarantine was expanded. In April of 2014, the county quarantine system ended and the entire state was added to the USDA APHIS list of regulated areas. This regulated region is historically the largest area in the nation that has been under Plant Protection and Quarantine. As such, APHIS proposed to remove the domestic quarantine and refocus their efforts on biological control of this exotic pest. This proposal was approved and took effect in January 2021.

EAB has been confirmed in 96 Kentucky counties to date (Figure 2). Ever since its arrival, EAB activity had led to mass mortality throughout our northeastern counties and decline continues to spread westward (Figure 3). In 2020, EAB was confirmed in four new counties: Daviess, Henderson, Monroe, Muhlenberg, and will eventually impact ash resources across the entire state as the infestation continues to spread into western Kentucky. Infestations in neighboring states of Indiana, Illinois, Missouri, and Tennessee can only aid this expansion within the coming years.

The Kentucky Division of Forestry (KDF) will continue to monitor this pest's progress in 2021.



EXOTIC INSECT PESTS

HEMLOCK WOOLLY ADELGID

The eastern hemlock is a foundation species within the riparian habitat in which it's found (Figure 4). However, this integral species is under attack from the hemlock woolly adelgid (HWA). This pest is an exotic species with origins from Japan and was first detected in the eastern United States during the 1950s. It wasn't until 2006 when this insect invader was first discovered in Kentucky. Approximately 98% of Kentucky's hemlocks are found in the eastern one-third of the state. In this region, infestations currently occur in 31 counties resulting in decline and mortality (Figure 5).

The Kentucky Division of Forestry's Forest Health Program has a field crew, pictured below, responsible for treating hemlocks to prolong the survival of this ecologically significant tree. Chemical insecticide treatments are employed in order to suppress HWA populations (Figure 6). Treatments began in 2009 on Kentucky State Forests and has since expanded to include properties managed by Kentucky State Parks, Office of Kentucky Nature Preserves, KDFWR Wildlife Management Areas, and USFS Daniel Boone National Forest (DBNF). Since 2009, KDF has chemically treated over 195,000 hemlock trees.

Recently, KDF has also released two species of predatory beetles that feed especially on HWA within the DBNF in hopes of creating a future field insectary site (Figure 7). Although there has been no evidence of predatory beetle establishment within the release sites to date, upcoming releases will take place adjacent to past release sites to increase chances of establishment.

We will continue to improve upon this integrated pest management program in 2021 with further chemical and biological control of this invasive pest.

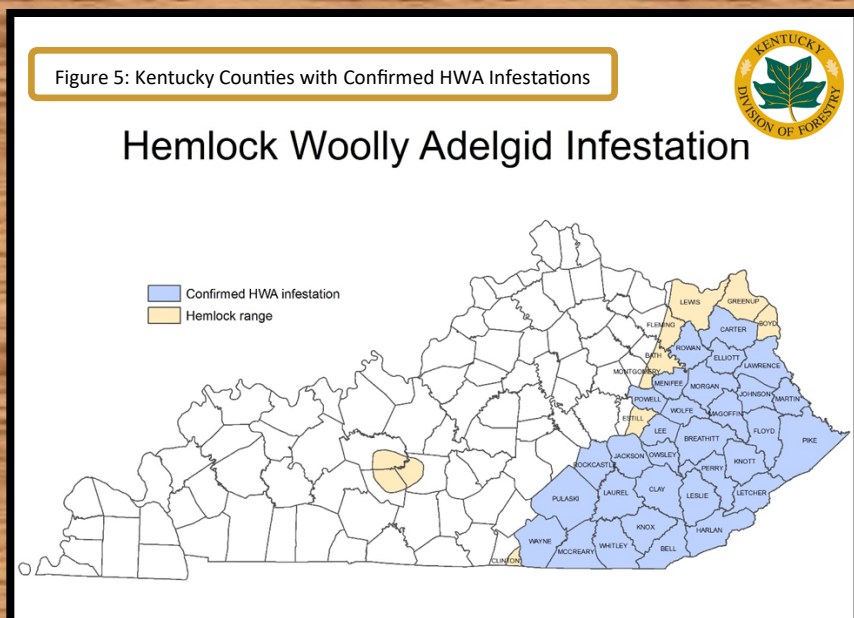
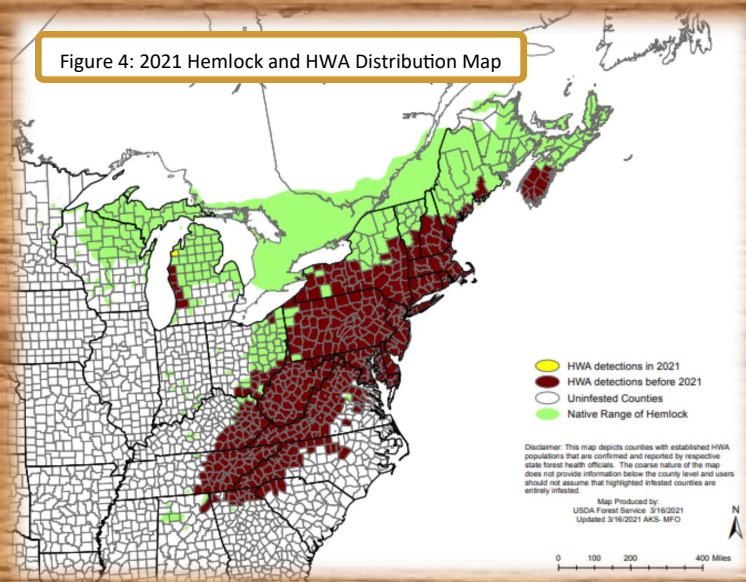


Figure 7: *Laricobius nigrinus*, a species of predatory beetle that specializes on HWA - Photo courtesy KY Heartwood



Figure 6: Chemical treatment of hemlock using a soil drench technique

NATIVE INSECT PESTS

Exotic pests aren't the only insects damaging our woodlands. There are also a number of native insect pests that locally impact our forests every year. Yet, the significance of these native pests fluctuates over time. While these native insects typically don't cause the same level of damage as their non-native counterparts, they can become an issue when coupled with additional stressors such as drought. KDF is constantly on the look-out for damages from such native pests.

YELLOW-POPLAR WEEVIL

Much of eastern and central Kentucky experience periodical outbreaks of the yellow-poplar weevil (Figure 8). Generally, this native insect is considered a minor pest, but the weevil was reported at higher than normal levels the past few years. Browning yellow-poplar trees were reported again this year (Figure 9). Making this the fourth consecutive year feeding damage from this forest pest has been observed in locations across eastern Kentucky (Figure 10). However, this year's damage seems to be lesser in severity and spread as in previous years. Two limited surveys were conducted to determine the general extent. No major decline has been documented from the recent infestations, though periods of drought that occurred in 2019 and the consecutive late cold snaps that followed this year could lead to future localized decline.



Figure 8: Yellow-poplar Weevil Adult



Figure 9: Browning Yellow-poplar



Figure 10: Yellow-poplar Weevil Feeding Damage

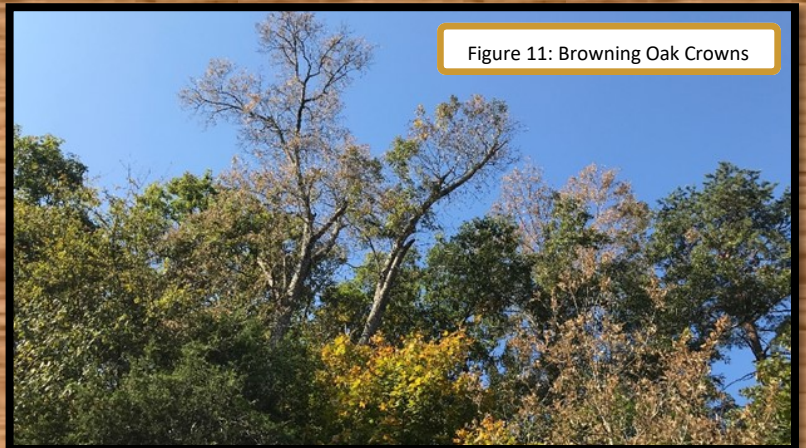
SCARLET OAK SAWFLY

This year, browning oak trees in central Kentucky, specifically Bullitt and Franklin counties, were reported for the first time (Figure 11). After further investigation, this native forest pest's feeding damage was found to be the causal agent (Figure 12). Limited ground surveys were conducted to determine the extent of the damage. No major decline has been noted, though recent extreme weather events could lead to future localized decline. Normally, this damage type has most often been observed in the eastern portion of the state.

Figure 12: Scarlet Oak Sawfly Larvae and Feeding Damage



Figure 11: Browning Oak Crowns



NATIVE INSECT PESTS

LOCUST LEAFMINER

Outbreaks of the locust leafminer are very common (Figure 13). These outbreaks vary in intensity and location from year to year. This year, damage was detected across many of Kentucky's north central counties (Figure 14). No formal surveys take place to record this pest annually due to the persistent damage year to year, but rather general observations are used to record hotspots that experience damage each year.



Figure 13: Locust leafminer adult and its feeding damage

Figure 14: Browning Black Locust trees due to this native pest in northern Kentucky



OAK SHOTHOLE LEAFMINER

Historically, outbreaks of the shothole leafminer have been a somewhat normal occurrence for nurseries as this insect is usually considered an ornamental pest. However, this past year has forest health specialists across the Eastern US re-considering this classification. In fact, in 2020 multiple states detected landscape-scale damages from this insect and confirmed it a major forest pest. An outbreak on this scale has never been seen before with this insect. Therefore, many professionals are unsure if this novel incidence will affect host trees, and if so, how. The female fly is the cause of the shothole appearance in leaves, hence the common name for this insect (Figure 15). This unique damage type is created during her feeding and oviposition through the use of the needle-like ovipositor on swollen buds just before leaf-out. As the new leaves expand, the puncture holes magnify. The juvenile form of this insect, a maggot, also causes further damage to the foliage of the host tree by mining within the tissue as it develops.

Feeding damage from this native fly species was detected across the entire state. Red and white oaks alike displayed the shothole signature in central, western, and eastern Kentucky counties (Figure 16). No formal surveys took place to record this damage in Kentucky this year, but rather general observations were used to record locations that experienced widespread damage. Evidence suggests that this species' outbreaks can last for one to three years. Thus, we will need to be vigilant in tracking this damage type within the Commonwealth over the coming years. KDF plans to initiate formal monitoring this insect in 2021.

Figure 15: Oak Shothole Leafminer Fly



Photo courtesy <https://www.mendhamnj.org>



Figure 16: Shothole Signature in Shingle Oak

INVADERS ON THE HORIZON

There is also a myriad of pests that have yet to make their way into Kentucky. These looming threats would cause extensive damage to our forests, which is why they demand our attention and awareness. These pests may never make it to Kentucky. It all depends on the quarantines put in place by the federal government and additional regulatory efforts by various state and private stakeholders. Even under these strict guidelines, we each must do our part to ensure that we aren't moving infested material.

EUROPEAN GYPSY MOTH

The European gypsy moth caterpillar is an aggressive defoliator that possesses a strong preference for oak species (Figure 17). This is unfortunate for our state since the predominant forest-type here is oak-hickory, which covers 76% of our woodlands. Gypsy moth surveys have been conducted since 2005 through various agencies and programs. Thankfully this pest is not yet established in Kentucky, although it has been detected every year since the surveys began. Kentucky's Office of the State Entomologist annually traps for gypsy moth using detection surveys through USDA APHIS and Slow the Spread (STS) programs. In 2020, traps were placed in 93 counties across the state. Five positive traps were found across the five counties with a total of seven moths captured. Counties with positive traps include Barren, Campbell, Fayette, Floyd, and Laurel. Positive trap catches were up from 3 moths captured in 2019, yet substantially lower than 68 moths in 2016, and 171 moths in 2015. This is an excellent example of a successful early detection and rapid response system. The efforts of the STS program have kept this pest at bay and the pressure off Kentucky (Figure 18).

Figure 17: Gypsy Moth Caterpillar

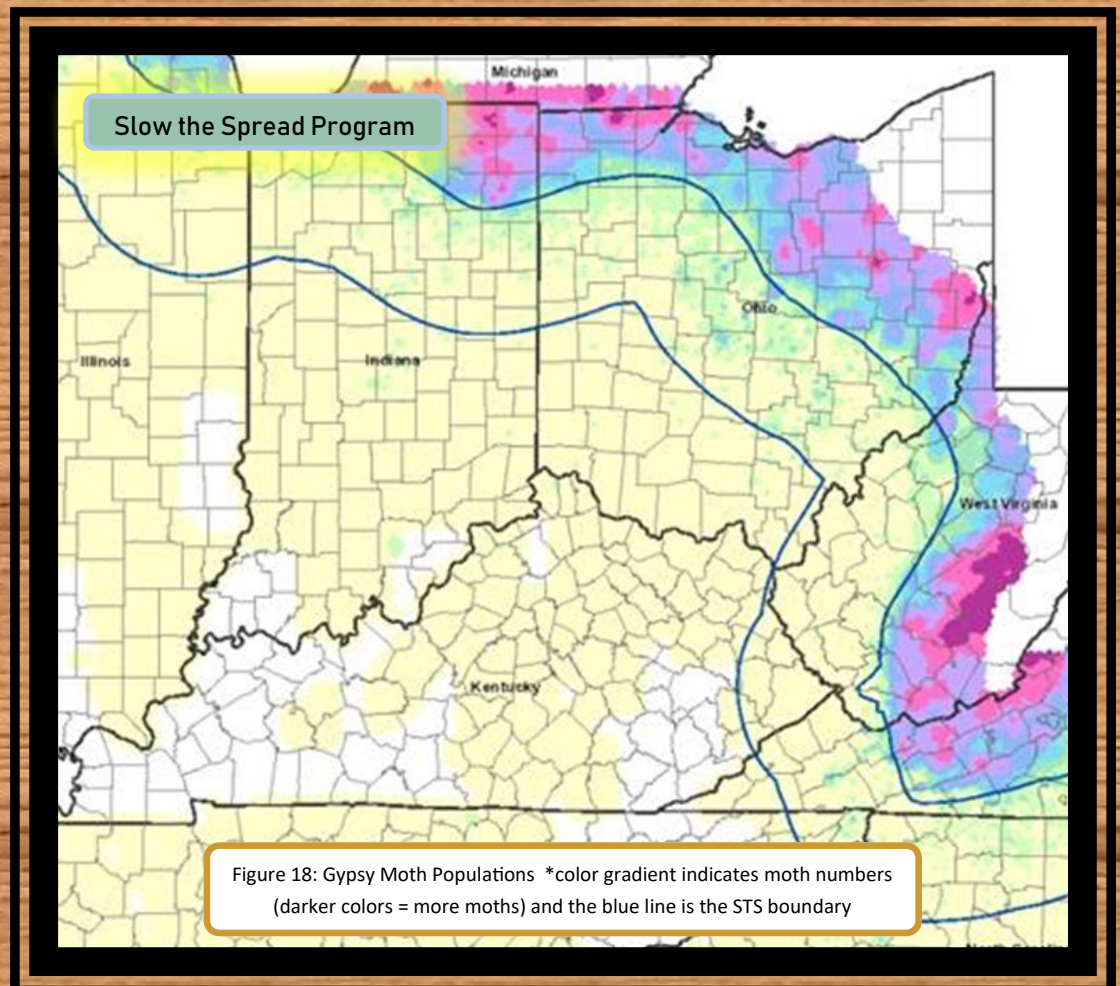


Figure 18: Gypsy Moth Populations *color gradient indicates moth numbers (darker colors = more moths) and the blue line is the STS boundary

INVADERS ON THE HORIZON

ASIAN LONGHORNED BEETLE

The Asian longhorned beetle (ALB) continues to be a potential pest of concern for Kentucky (Figure 19). Although ALB has not been found within the Commonwealth, in 2011 it was discovered in Clermont County, Ohio, a mere 10 miles from our northern border. More recently, ALB was confirmed in Charleston County, South Carolina in June 2020. Eradication efforts are currently underway. Here are the common signs of ALB activity. The females chew oviposition pits on host trees, most commonly maple, and lay a single egg beneath the bark. Then the larvae hatch and feed on the sapwood for a short period of time before moving into the heartwood. When adults emerge, they create noticeably round exit holes that can be as large as a dime (Figure 20). KDF works with various agencies to educate the public on ALB identification and signs of infestation.

Figure 19: Asian Longhorned Beetle Adult



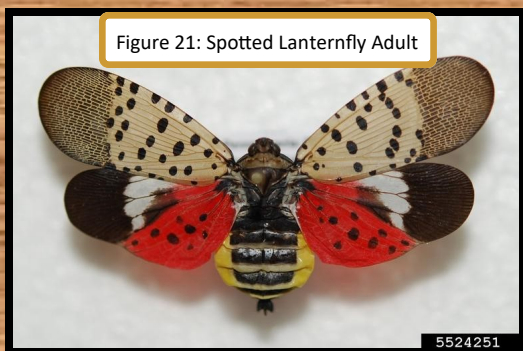
Figure 20: ALB Feeding Damage



SPOTTED LANTERNFLY

The spotted lanternfly (SLF) is a relatively new invasive insect to the US with origins from Asia. It was only first discovered in Pennsylvania in 2014. It can be described as beautiful, but it is also dangerous (Figure 21). Don't be fooled by its name, this insect isn't a fly at all. It is actually a hemipteran which uses its characteristic, piercing and sucking mouthpart to steal nutrients right out of its host. It is thought that tree of heaven is their primary host species, but they also show preference towards red maple, black walnut, and various other fruiting trees and vines. Damage from this insect's aggregate feeding behavior can weaken the host, leaving it susceptible to other stress agents. Although the SLF hasn't been found in Kentucky, it was recently discovered in West Virginia in October of 2019 and in North Carolina in December 2020. Currently, there is no federal quarantine in place for this pest. Yet, some states have taken it upon themselves to provide regulations for their infested areas (Figure 22).

Figure 21: Spotted Lanternfly Adult



Spotted Lanternfly Reported Distribution
Updated March 12, 2021

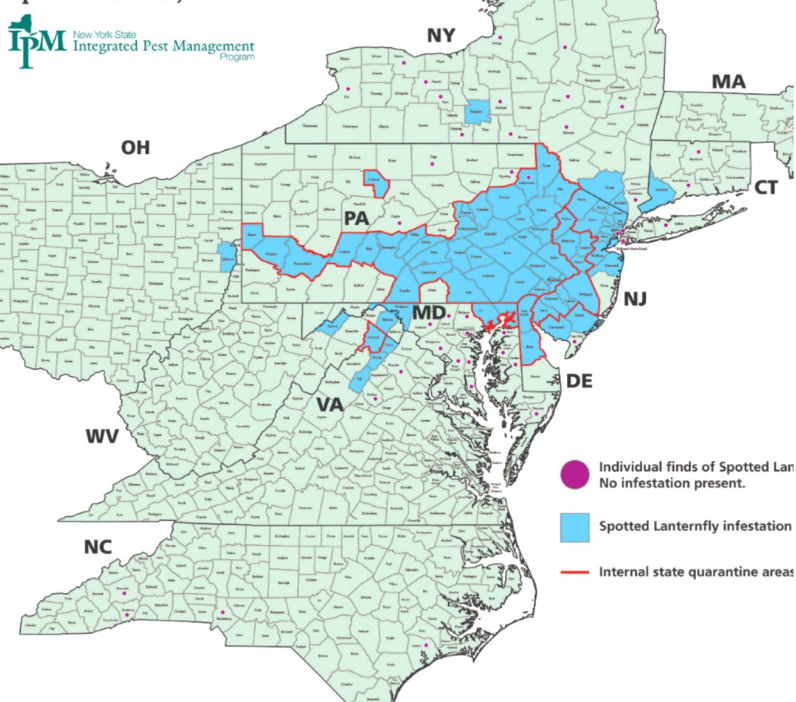


Figure 22: SLF Distribution Map *blue areas indicate infestation, purple dots are locations where SLF have been found, and the red line shows the state quarantine areas

DISEASES

LAUREL WILT DISEASE

In 2019, Laurel Wilt Disease (LWD) was first documented in Kentucky in Christian, Todd, and Logan Counties. LWD was first confirmed inside the Fort Campbell Army Base after large sassafras trees were reported dead. After this initial detection, ground surveys were used to learn the extent of the outbreak. Just this past year, a record-setting seven new counties were added to the map. Those counties include: Trigg, Simpson, Barren, Allen, Green, Hardin, and Jefferson (Figure 23). The majority of these additional detections conjoin with the previously confirmed counties along the southern border with Tennessee, where this disease has also been confirmed. However, the Hardin and Jefferson County detections present an outlier as they touch the northern reaches of the Commonwealth. Thus, we can only expect this novel disease to materialize in other areas across all regions of the state.



Figure 25: Sapwood Staining

Redbay ambrosia beetles vector this disease by boring into trees and transmitting the pathogen within the wood. A single beetle can transmit enough spores of the lethal fungal pathogen, *Raffaellea lauricola*, to kill a tree. The fungus infects the xylem, blocking off the vascular system, causing wilting and eventual mortality. Death can occur within weeks to months after being infected. Yet, there is evidence to suggest that sassafras can surpass the initial infection and survive for an extra year or two before succumbing to the disease. Signs of beetle activity include very small circular holes in the bark, occasionally accompanied by thin sawdust toothpicks of waste. Other symptoms to look for include early fall coloration or wilting of leaves on suspect trees that may remain attached for months (Figure 24). In most infected trees and shrubs the fungus causes distinctive, dark staining within the sapwood (Figure 25).

It is important to note that this disease complex is specific to plants within the Laurel Family. Sassafras and spicebush are the only two species found in Kentucky that LWD is known to attack. As of now, we only know of severe impacts to sassafras. However, the first observations of infection in wild spicebush were documented and confirmed within the Fort Campbell Army Base in 2020. There will be more to come with work surrounding this host plant next year.

KDF is still working on the logistics for a pilot study in cooperation the USFS Southern Research Station that will investigate the efficacy of a fungicide treatment as a method to combat this disease in municipal sassafras trees. The Commonwealth could need this more than we know as the national champion, and possibly, the world's largest sassafras tree is located in Owensboro, Kentucky.

Laurel Wilt in Kentucky



Confirmed in:

- Initial county level confirmed location
- 2019
- 2020

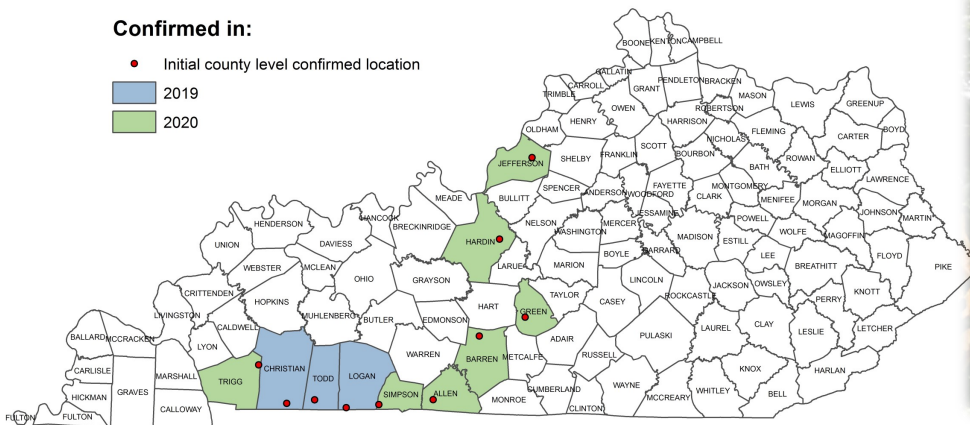


Figure 23: 2020 Laurel Wilt Distribution Map

Last updated: January 28, 2021

Figure 24: Foliar Symptoms of LWD



DISEASES

LAUREL WILT DISEASE CONTINUED...

As previously mentioned, the first-ever infected spicebush has been found in the wild. This is terrible, yet exciting, news since past research had suggested that the redbay ambrosia beetle didn't show a strong preference for spicebush in the laboratory setting. We now have evidence from the field to suggest otherwise. Please make yourself aware of the following tell-tale signs as we need all the help we can get to find new locations of infection across the region. As you can see, spicebush displays the same symptoms as sassafras when affected by LWD. Early fall coloration in the form of golden hued foliage can be seen in the summer months (Figure 26). Frass toothpicks left behind by the beetle vector litter the boles of infected spicebush (Figure 27). The iconic staining of the sapwood can be seen in the cross-section of this freshly cut sample (Figure 28). And the final stages of wilt that dry out not only the leaves, but also the fruit, which marks the lethal blow (Figure 29).

Figure 26: Early Fall Coloration in Spicebush

Figure 27: Frass Toothpicks Hanging from Spicebush Bole

Figure 29: Wilted Leaves and Fruit of Spicebush

Figure 28: Spicebush Sapwood Staining

“A PROUD KENTUCKY MOMENT”



To date, Kentucky is the first and only state to ever use aerial detection to locate new locations of LWD. In 2020, KDF flew over a million acres looking for areas of sassafras decline and mortality related to this deadly disease. Resulting from that survey work, two new confirmations were made in Simpson and Barren Counties. We can now use this as a new tool for future detections.

Franklin, KY in Simpson County

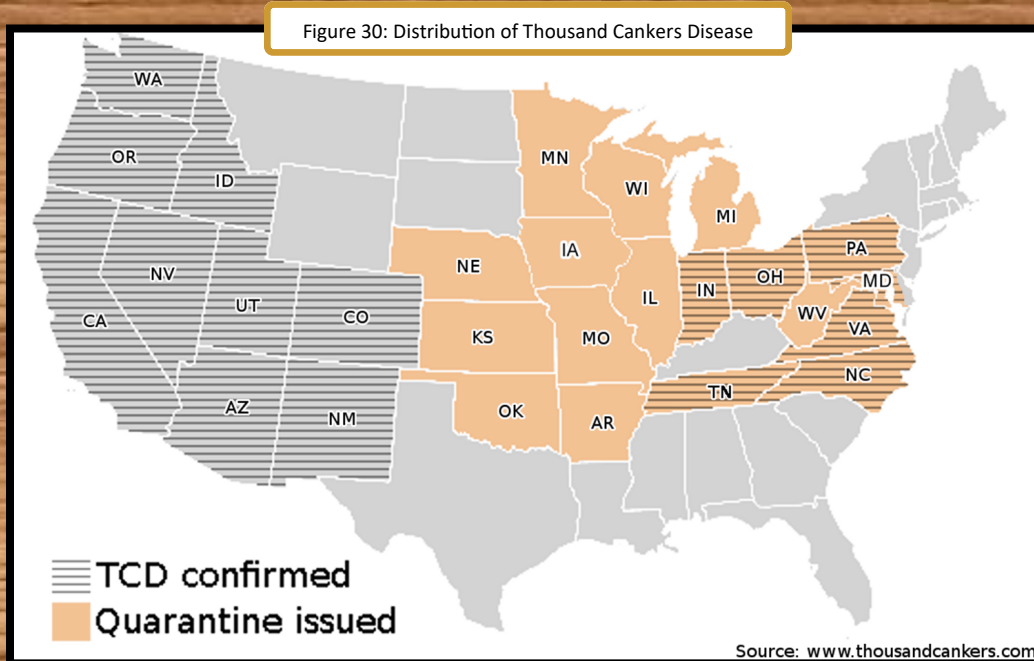
Horse Cave, KY in Barren County



DISEASES

THOUSAND CANKERS DISEASE

Thousand cankers disease (TCD) of eastern black walnut is caused by the fungal pathogen, *Geosmithia morbida* and its insect vector, the walnut twig beetle. It was first recorded in the eastern United States in 2010. Yet, neither the pathogen nor the vector of TCD have been confirmed in Kentucky even though there have been confirmed cases in the neighboring states of Indiana, Ohio, and Tennessee (Figure 30). A monitoring program has been conducted within the Commonwealth for many years, and thus far, no beetles have been found. In 2020, KDF placed 8 funnel traps in six north central counties, including Franklin, Owen, Carroll, Gallatin, Boone, and Grant to monitor for the walnut twig beetle (Figure 31). This program will continue in 2021.



BACTERIAL LEAF SCORCH

Bacterial leaf scorch (BLS) is vectored by various leafhopper and treehopper species and it affects multiple tree species including elm, maple, sycamore, and oak. This disease is common on many urban landscapes throughout the state. This year numerous landowner reports, predominantly from central Kentucky, came in pertaining to this issue. Symptoms include a scorched leaf appearance that presents itself in July and progressively gets worse through the end of summer (Figure 32). Symptoms occur annually as the disease progresses through the crown. Reduced growth and branch dieback soon follow, resulting in slow decline and eventual death of the tree (Figure 33).



EXTREME WEATHER



In the spring of 2020, Kentucky was hit hard by two major frost/freeze events. The first occurred over the days of April 15th and 16th where temperatures dropped to record lows across the entire state. Temperatures dropped into the mid-twenties in all regions and impacts to various forest types were observed. The injuries from this cold snap were worsened by the very warm weather, with temperatures in the 70s, just the month before. The temperature rise in March caused an early green-up in woodlands spanning the state. This young leaf development was essentially paused by the following cooler weather in April. The second late freeze hit Kentucky on May 9th and 10th where temperatures once again plummeted into the 20s and 30s statewide, setting a new record low. The hardest hit areas were in the mountainous regions of eastern Kentucky. This late cold snap had devastating impacts on orchard trees in the area such as apple, pear, and peach.

These two frost events damaged different species at various levels based on location within state and localized site conditions. Damage was highly dependent on what species were in the more susceptible early leaf out stages during the time of these events. The western portion of the state was further along in development during the April frost, which resulted in damages to species such as bottomland oaks. Yet, not damage occurred to the same or similar species in eastern Kentucky as they had not yet leafed out. Local site conditions such as broad elevation gradients, specifically areas with mountains and valleys, also impacted levels of damage.

Yellow-poplar and sycamore were two of the most widespread and damaged species statewide. Both species were generally hit twice by the back-to-back events and therefore experienced two defoliation events. It will be interesting to see how yellow-poplar responds after also being impacted by the severe drought in 2019. Reports and observations from the eastern region document extensive damage to poplar and sycamore in April and localized damage and delayed leaf out to bottomland oaks, hickories, ash, and walnut in May. In western Kentucky, bottomland oaks, yellow-poplar, blackgum, and sycamore were effected during the first cold snap. Surveys in central Kentucky confirmed once again widespread damage to poplar and sycamore in April's freeze event. During the May cold snap damage was seen in the Bluegrass Region to hackberry, mulberry, yellow-poplar, sycamore, sassafras, and walnut in locations that had already broken bud. In an additional survey of Knobs State Forest, damage was observed on forest edges to various species of hickory and red oak. Drainages throughout the state made up of yellow-poplar and sycamore were all damaged and very delayed in new leaf growth. In some areas where conditions were just right, nearly all species that were green at the time were damaged by the extreme freeze. This produced noticeable lines between damaged low lying valleys and green areas in higher elevation.

FOREST HEALTH ASSISTANCE IN KENTUCKY

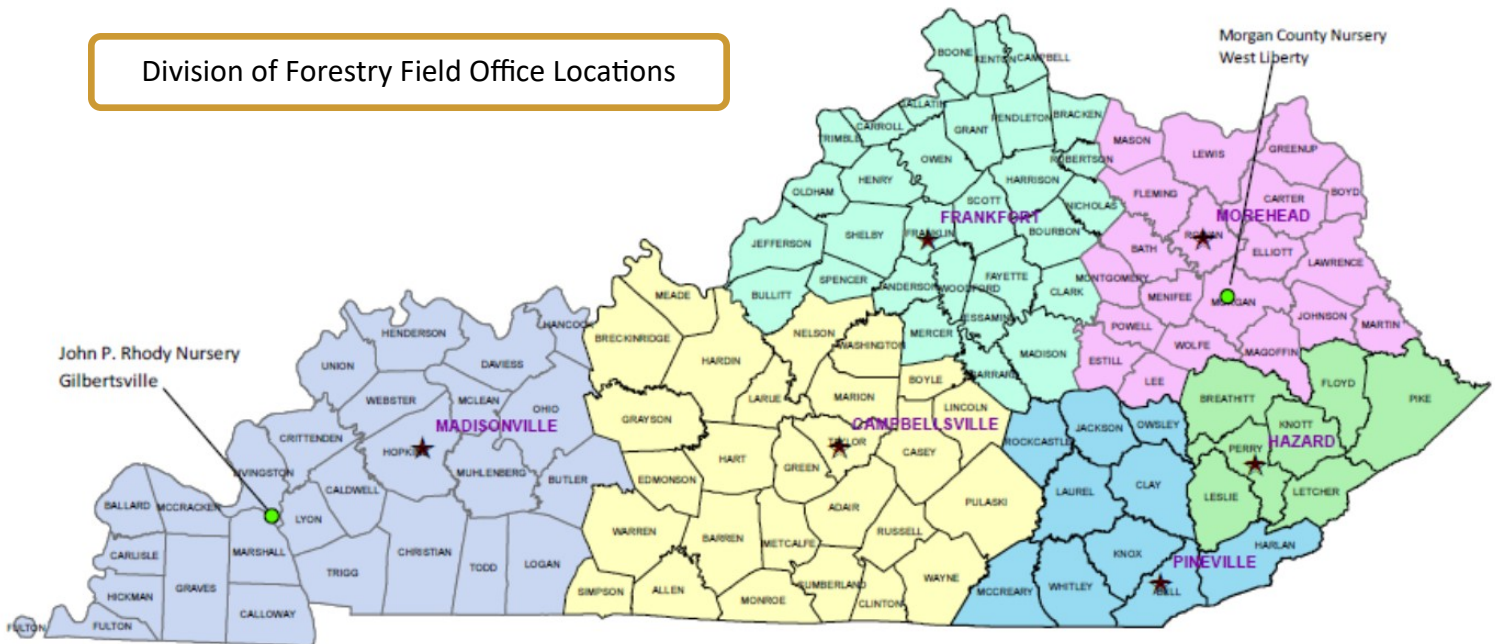
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270-465-5071	502-573-1085	606-783-8625	606-435-6073	270-824-7527	606-337-3939

References:

- USDA APHIS provided the Federal Quarantine Maps
- Photos with image numbers are courtesy of Bugwood.org